What prompted a CTDOT Enterprise GIS infrastructure rebuild and where it is today

William Pratt PE – AEC Applications
Gregory Ciparelli - Roadway Information Systems

The theme for this year's conference is "Implementing Change and Growing Technology"

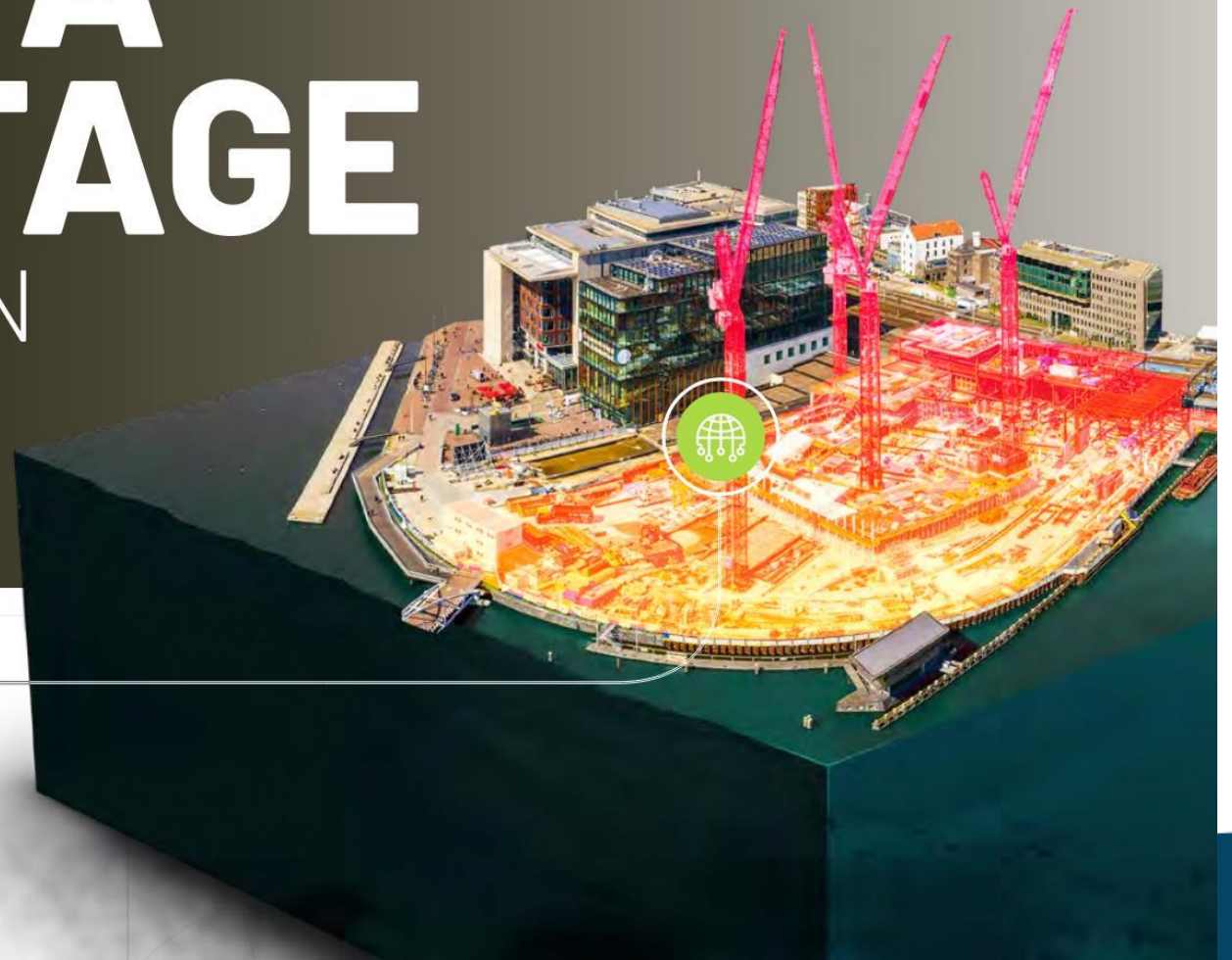
- How a 2010 executive team request for project mapping and information lead to CTDOT’s TED (Transportation Enterprise Data) development effort.
- The underlying geospatial LRS (Bentley’s AWLRS) is the backbone of CTDOT’s base map and harbors all authoritative road network attribute and characteristic information.
- CTDOT’s appetite for authoritative data used for enhancing Capital Project delivery and Asset Management. CTDOT’s eGIS infrastructure and governance.

A Quick Pitch for Good Data

- A couple slides from an Autodesk FMI 2021survey

HARNESSING
THE DATA ADVANTAGE
IN CONSTRUCTION

Why adopting a data strategy can bring firms a competitive edge.



FMI AUTODESK

EXECUTIVE SUMMARY

In construction, decisions are usually made in an environment where some amount of data is available to consider. But all too frequently, that data is not easily accessible for quick decisions, or even worse, the available data is simply bad*. Across the globe, the ability to utilize data in an insightful manner is no longer a nice-to-have, it has become a primary source of competitive advantage. Those who utilize their data to make informed decisions and gain performance insights from it will ultimately emerge as leaders in construction.

The research shows that adopting a data strategy can eliminate many avoidable costs in construction, both direct and indirect. It's clear that making decisions using "good" data can propel an organization to a higher level of performance. Fortunately, the future for a data-driven construction industry is bright—with many industry leaders identifying that hiring employees with data management skills is now a core component of their operating model.

Read on to learn more about the impacts bad data has on the construction industry. Throughout this report you will find insights from industry leaders on how to begin creating your own data strategy, including actionable steps that can quickly bring improvements to how your organization manages data.

When asked about their current relationship with construction data, respondents indicated...

- Volume of available project data **DOUBLED** in the last 3 years
- **75%** stated an increasing need for rapid decision-making in the field
- An alarming 30% shared that over **50%** of their data is **bad**
- Only **36%** have implemented a process for identifying bad data and repairing it

Bad Data = Bad Outcomes. Respondents stated...

- **55%** have implemented a formal data strategy for project data
- **12%** always incorporate project data into their decision-making
- **1/3** of all poor decisions were made as a result of bad data

The cost of bad data is high. In 2020 ...

Global GDP was **$84.5 TRILLION****

Construction accounted for **13.2%** of Global GDP **

- Bad data in construction may have cost **$1.84 TRILLION** due to poor decision making**
- Additionally, bad data may have caused **14%** of all construction rework**
- causing **$88.69 BILLION** * in avoidable rework worldwide*

What does this mean for you? Here's an example...

The total cost of bad data for a contractor performing **$1 BILLION** in annual revenue

- could be as high as **$165 MILLION** **
- including **$7.1 MILLION** ** in avoidable rework directly caused by bad data**

*Bad data is either inaccurate, incomplete, inaccessible, inconsistent, or untimely. It cannot be used to provide either usable information or actionable insights.

**See a detailed cost breakdown on page 13 of this report.

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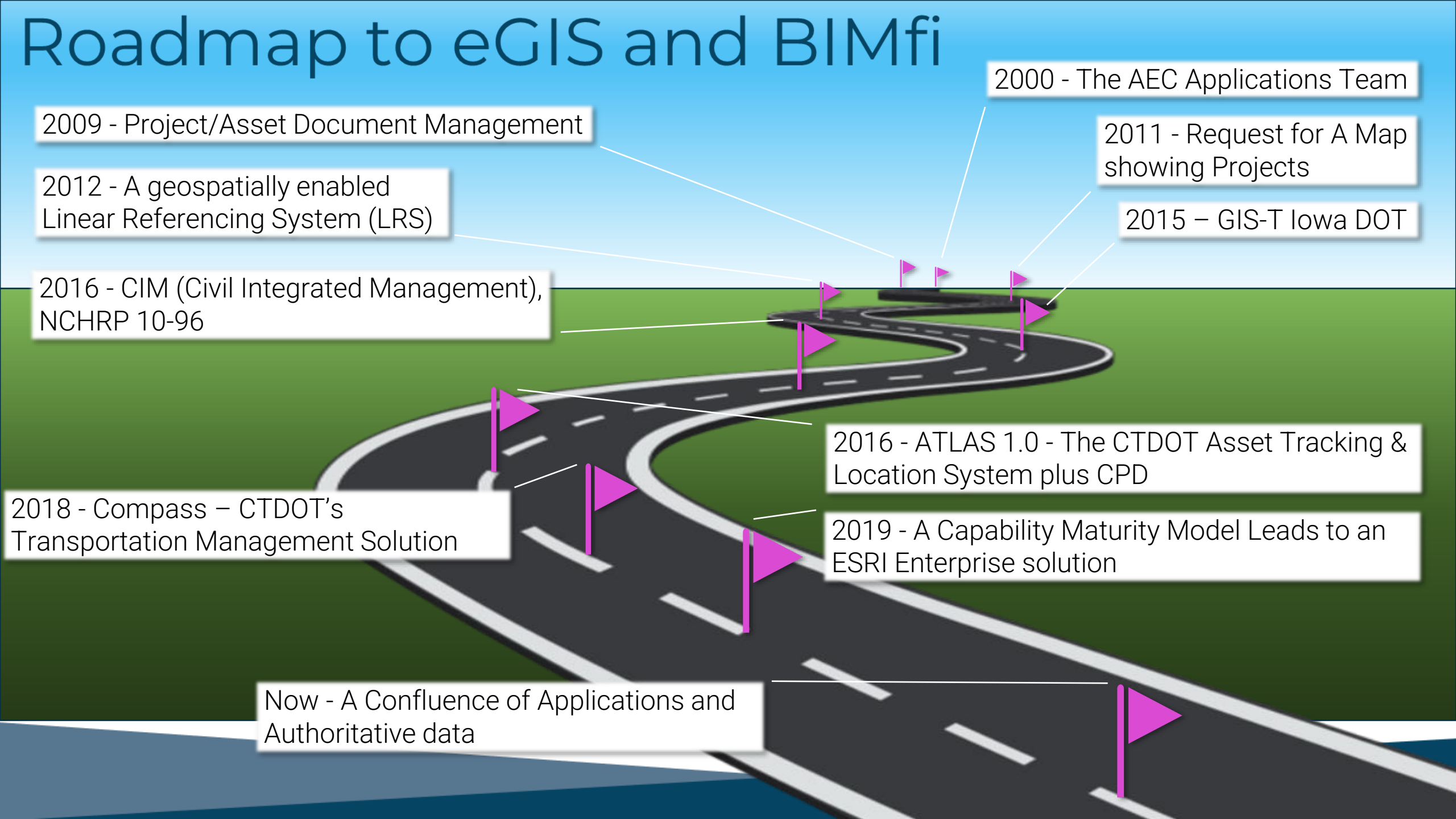
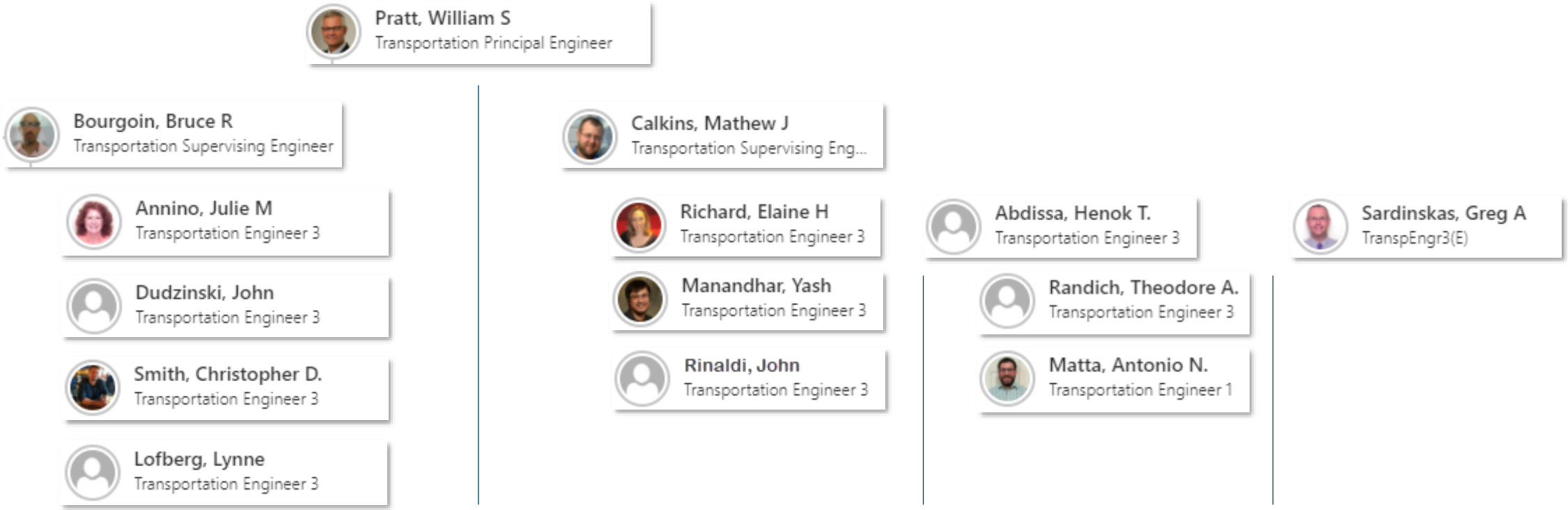
Roadmap to eGIS and BIMfi



2000 - The Team – AEC Applications

- Replaced the CAD Manager and changed name and mission
- Focused on Engineering applications and delivering projects for State and CE's
- Brought in other discipline Engineers from Highway, Traffic, Bridge, Survey, and Facilities
- 1st effort was to develop a project centric data model for CAD modeling and proper securities (X: Drive)
- Build out of our Digital Project Development Manual version 1.0

AEC Applications



Transportation Project Management Applications
Cradle Grave business solutions

CAD & BIMfi Apps

GIS & BIMfi Apps

Construction BIMfi Apps

2009 - Project/Asset Document Management

- ProjectWise Online Hosted by Bentley Inc
- 1st Cloud application at CTDOT
- Required two years of lobbying with Statewide IT
- Centerpiece in CTDOT's May of 2011 transformation from paper/mylar to a digitally signed PDF for Electronic Delivery
  - True cloud collaboration with CE's delivering directly to their projects
  - Progressive contract plan format that saved $1.2 Mil/yr in time, paper reduction and digital processes
  - Developed a digital signing solution that was adopted by CT's PE and LS Board

2011 – Request for A Map showing Active Projects

- Started with an executive request for an Active Project Info Map
- Two challenges
  - Geospatial Project Location (GPL)
  - Project information (CPD)
- Then it grew into many more questions:
  - GPL
    - Where are the roads (LRS Spinoff Project)
    - How can we locate the projects and **give value to the Designers**
  - CPD
    - Updating project data and how often (automate the reporting)
    - What business systems can we harvest from
    - CPD (Composite Project Database) was developed

2012 – A Geospatially Enabled Linear Referencing System (LRS)

- Business Requirements collected 2012
- Productionized LRS 2017
- Inspired with the amount of **authoritative** data that was available especially the Route ID’s
- This started the vision for ATLAS 1.0

2015 – GIS-T Iowa DOT

Quote:

Paul Trombino

Former Director, Iowa DOT & AASHTO President

“I don’t think construction of infrastructure is our primary role anymore. I believe we are now facilitators of information.”

2016 - NCHRP 10-96 CIM (Civil Integrated Management (CIM) in DOTs

- Project Panel Member
- Very inspiring exercise that helped develop vision and roadmap for CTDOT
- Inspired us to continue to develop better data relating to projects and effected assets
- CIM is now BIMfi, we should all look back at 10-96 for valuable insights and recommendations. They all apply to BIMfi.

2016 - NCHRP 10-96 CIM (Civil Integrated Management (CIM) in DOTs

- “CIM is meant to serve all project stakeholders (for example, owner, operator, constructor, designer, surveyor, planner, and operations or asset manager) and consistently provide appropriate, accurate, and reliable information throughout the asset’s lifecycle (that is, from initial planning through in-service maintenance and risk management)”

- “Besides the constraints, the current CIM maturity also plays an important role in determining the action steps.
  - Divisions with low CIM maturity can identify easy targets to help them with initial breakthroughs; also, there have to be sustained efforts to innovate and solve the constraints.
  - Divisions with high CIM maturity (Intermediate or Advanced) can continuously keep assessing and updating processes for potential efficiency improvements.”

2016 - ATLAS 1.0 – Capital Project and Asset Tracking

- CPD (Composite Project Database)
- ATLAS built on GeoMoose (Open Source from MinnDOT)
- 18 Authoritative GIS layers for LRS, Bridges & Signals and others
- Developed Local & Districtwide Project Work Areas
- Developed Project LRS Limits from Local Project Polygons
- Identified Project Work Programmed and Completed against Major Assets (FHWA Work Types)
- A History of Projects back to 2011 with 85 project attributes (2,900) projects
- A Legacy Dataset of Projects prior to 2011 with 12 project attributes (10,000) projects
- All Projects include URL’s to SharePoint Project Containers with Contract Plans and more

2018 - Compass – CTDOT's Transportation Project Management Cloud Solution

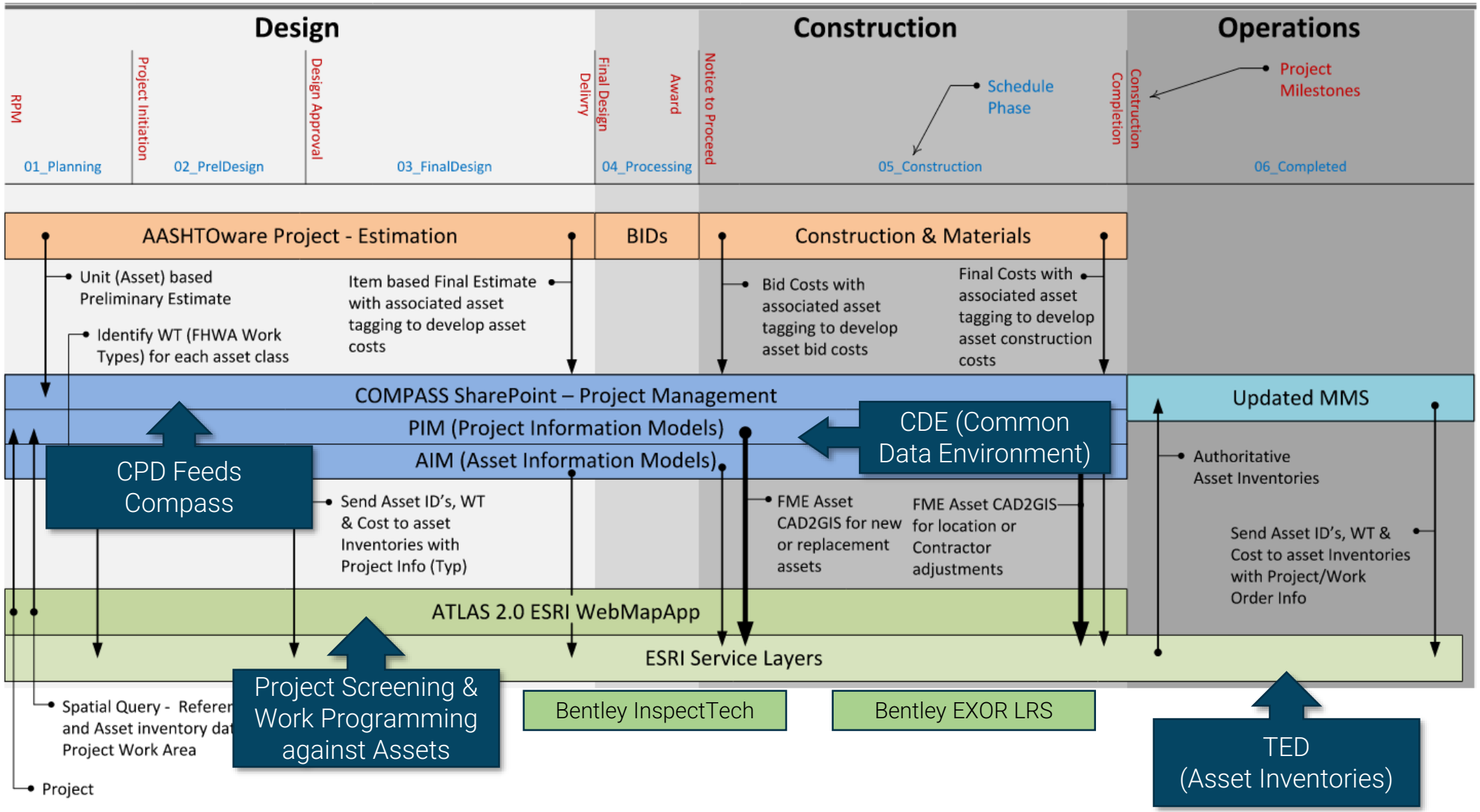
- Microsoft Commercial Off-the-Shelf Software (MCOTS)
- Customized SharePoint Solution
- Cradle to Grave, implementation started with Construction and will Complete all Design projects by 1/1/22
- Customizable BIC solutions for Submittals/Transmittals
  - Currently have processed over 50K Contractor Submittals
- CPD is the underlying project data provider
- Successful CAD solution using the OneDrive/SP Synching
- CDE for Project Documents and Data
- Replacing one off Document Management systems for larger complex projects
- Integration with ATLAS 2.0 being developed now in ESRI

2019 - A Capability Maturity Model survey Leads to an ESRI Enterprise solution

- The SLIMGIM-T CMM survey was instrumental in understanding our GIS Maturity, FHWA Case study
  - Organizational Structure and Leadership
  - Corporate Culture
  - Organizational Capability
  - Enterprise GIS sustainability
  - Foundational Data and Technologies
- Lead us to an ESRI Enterprise Solution

A Confluence of applications and Authoritative data

CTDOT Enterprise BIMfi and Asset Management



Transportation Enterprise Data

Collective Vision

Optimize the flow of knowledge, information and business intelligence within the CTDOT to support smarter and better decision making for internal personnel, stakeholders, and general public.

E.O. 39 Issued February 20, 2014

Goal

Create a single transportation enterprise geospatial data platform fed and maintained by authoritative data that supports access and analysis of Agency-wide information to a variety of stakeholders

McKinsey/IDC Study

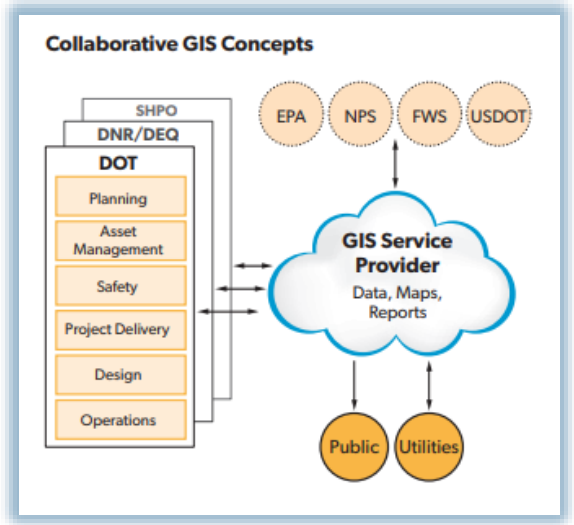
2012 McKinsey Study

On Average 19% of time for knowledge workers is spent searching for & gathering information – that's roughly 1 day every work week

2019 IDC Study

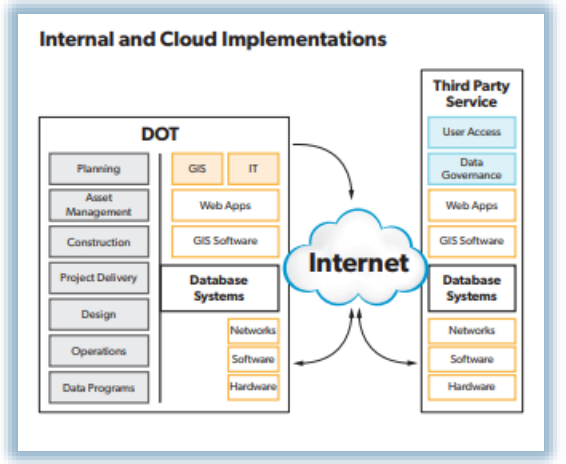
Data professionals are losing 50% of their time every week — 30% searching for, governing and preparing data plus 20% duplicating work

Geospatial Data Collaboration



Benefits of Geospatial Tools & Cloud Solutions

- **Sharing data and consistency**
- **Fostering collaboration**
- **Focusing the use of resources and potential savings**
- **Providing data accessibility**



Currently, most GIS and Web-mapping applications at Federal, State, and local agencies are housed internally. Building on current organizational and technical capabilities, ***this initiative will use innovative cloud-based GIS services*** to improve data sharing both within transportation agencies and among project delivery stakeholders. Collaborative analyses and rapid updating of shared common maps will lead to faster consensus building and improved decision support.

Challenges In Geospatial Data Collaboration

Timeliness	How quickly is a change in field conditions or status reflected in the data?
Accuracy	How do we ensure that individual populated data fields are error-free?
Completeness	How do we minimize the absence of data records & populate all applicable data fields?
Uniformity	How do we ensure that all jurisdictions within the state are location referencing in the same manner and using the same definitions for data elements and attributes?
Integration	How do we link databases utilizing common or unique identifiers?
Accessibility	How do we ensure that the data is available and useable to all appropriate interested parties?
Authority	Who programs road network or attribute changes on a state and local level or is responsible for maintaining state or local road data? Stewardship?

Key Decisions

Utilize the GIS and Geospatial LRS as the Components to Tie it All Together

- Many datasets siloed, but contain some geospatial or LRS integration – leverage those attributes
- Geospatial LRS enabled roadway characteristic data to become much more accessible

Flexibility with Integration

- Allow users to utilize existing systems wherever possible, with EGIS, SMEs, and IT assisting with integration of systems
- Don't destroy siloes, but link them instead

Data Governance

- Establish a multi-tiered approach to data governance
- Exert governance through architecture & data availability

Licensing Appropriately

- Entered Enterprise License Agreement with Esri – March 2020
- Increase FME licensing to enable business to assist in ETL and Integration

Utilizing Knowledge Resources

- Establish Enterprise GIS Unit – December 2019
- Create Subject Matter Expert (SME) team with Agency-wide representation

Licensing

3 year Enterprise License Agreement with Esri

450 Creator Memberships

150 Field Worker Memberships

Unlimited Viewers

ArcGIS Enterprise

ArcGIS Server

ArcGIS Desktop / ArcGIS Pro

FME Server & Additional Desktop Licenses

Product	Total Qty. to Be Deployed
ArcGIS Desktop: Advanced, Standard, and Basic (Single and Concurrent Use)	Uncapped
ArcGIS Desktop Extensions: ArcGIS 3D Analyst, ArcGIS Data Reviewer, ArcGIS Geostatistical Analyst, ArcGIS Network Analyst, ArcGIS Publisher, ArcGIS Schematics, ArcGIS Spatial Analyst, and ArcGIS Workflow Manager (Single and Concurrent Use)	Uncapped
ArcGIS Enterprise: Enterprise and Workgroup (Advanced and Standard)	Uncapped
ArcGIS Enterprise Extensions: ArcGIS 3D Analyst, ArcGIS Geostatistical Analyst, ArcGIS Network Analyst, ArcGIS Schematics, ArcGIS Spatial Analyst, and ArcGIS Workflow Manager	Uncapped
ArcGIS GIS Server: Advanced, Standard, Basic	Uncapped
ArcGIS Monitor	Uncapped
Mapping and Charting solutions: Esri Production Mapping for Desktop (Single Use and Concurrent Use)	Uncapped

Item	Rolled-In Qty. (if applicable)	Qty. to Be Deployed	Total
Drone2Map for ArcGIS Online Term license	0	1	1
Insights for ArcGIS Online Term license	0	10	10
ArcGIS Developer Subscription Professional Level	0	2	2
ArcGIS GeoEvent Server	0	1	1
ArcGIS GeoEvent Staging	0	1	1
ArcGIS Data Interoperability Desktop Extension (Concurrent Use)	3	0	3

Product	Number of Subscriptions	Named Users per Subscription	Annual Credits per Subscription
ArcGIS Online User Types*	1	20 Viewers, 450 Creators, 150 Field Workers	300,000

CTDOT's Internal Operations to Develop Data

TED-IT Planning Group

Meets weekly, develops strategies, provides direction and guidance, monitors key tasks.

GIS Standards /Change Management Team

Collaborative group management of high level users, training, database management, multidisciplinary team.

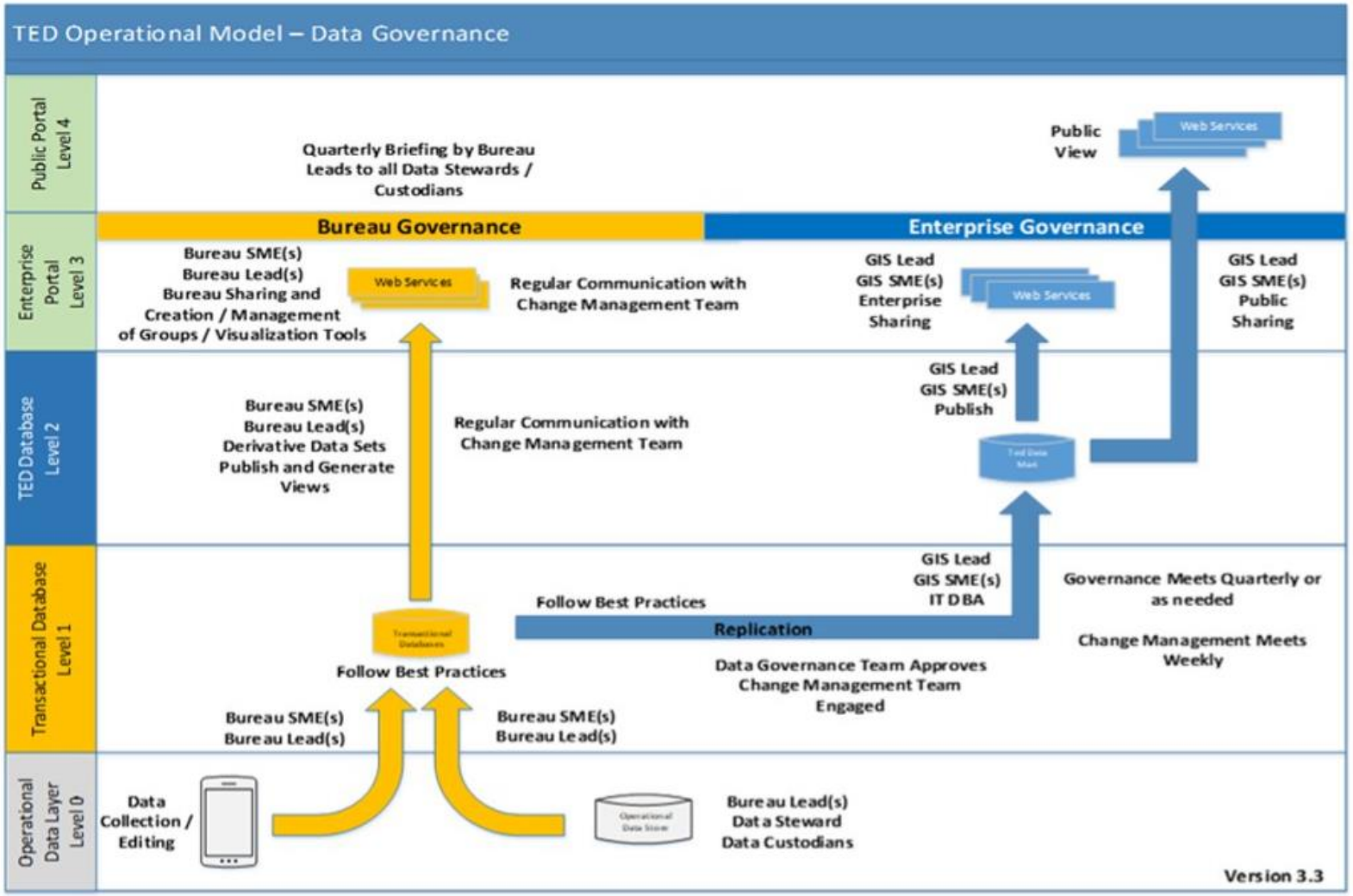
Enterprise GIS (EGIS) Team

Administers GIS at CTDOT, assist steward in data development and designing maintenance solutions, perform analysis, create visualizations.

IT Development Team

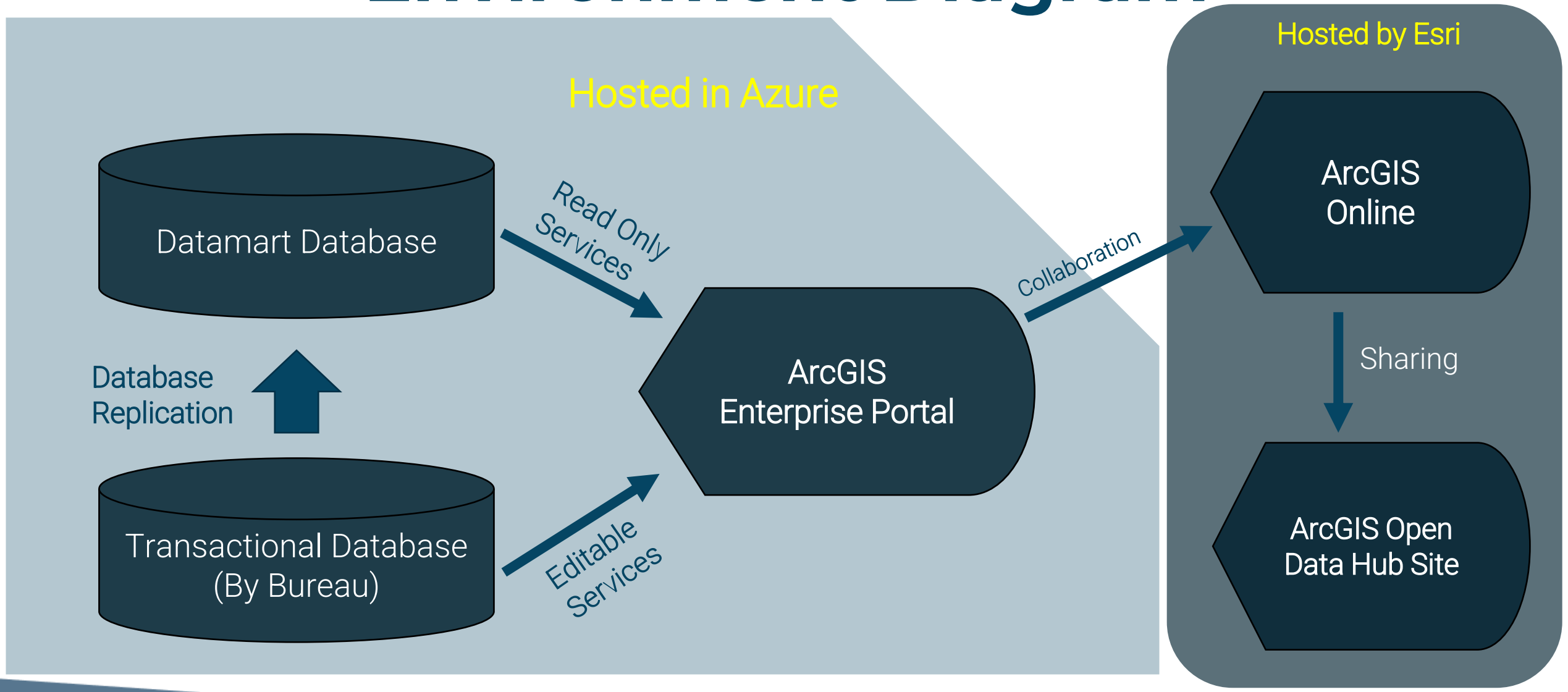
Supports business requirements; Configures servers in Azure Cloud; develops TED Architecture at DOT; creates and monitors security

Key Personnel & Processes



Data Governance

Environment Diagram



Esri Versioned Database Transactional Architecture

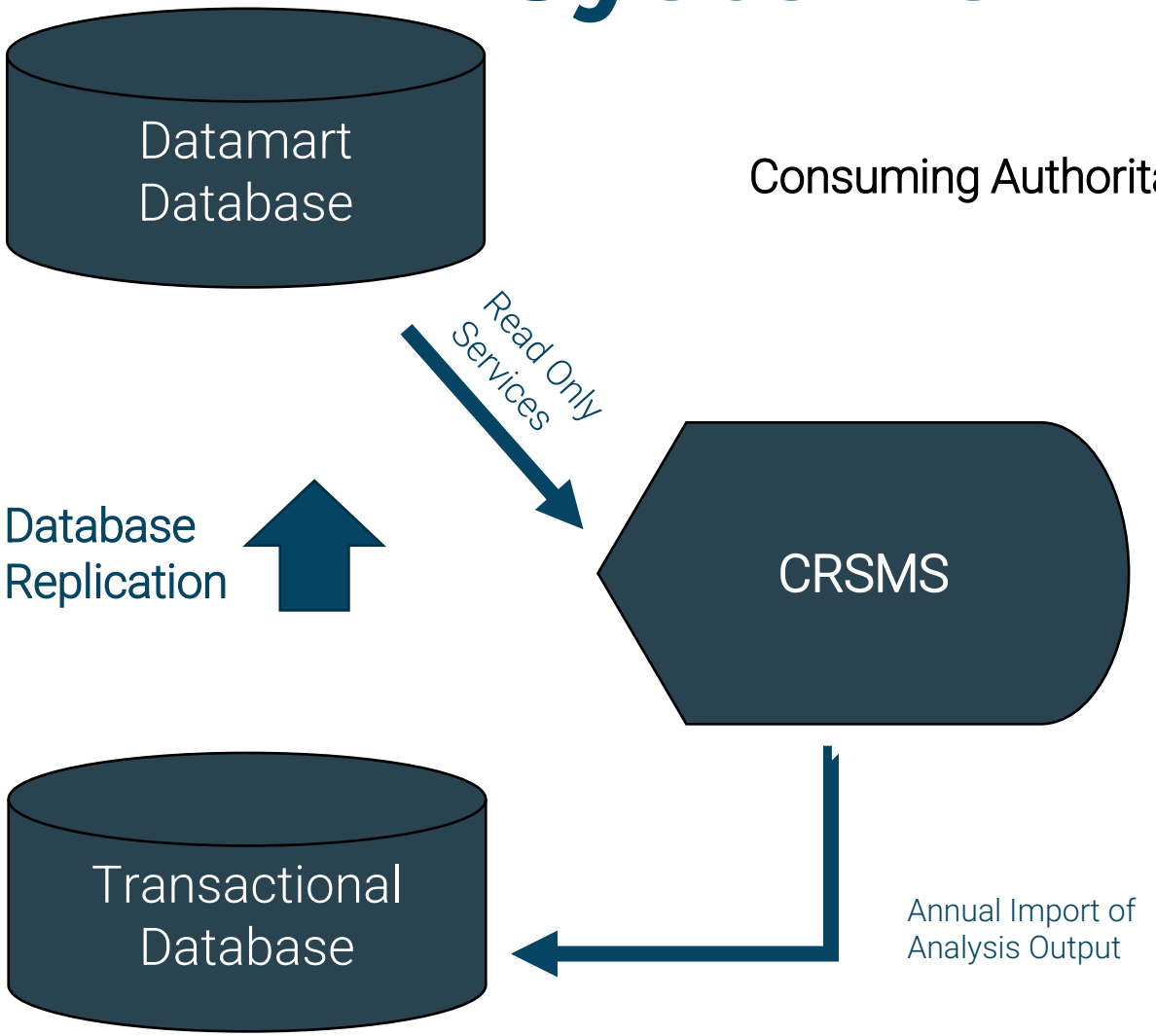
Supports multi-user editing environment

Enables Quality Assurance procedures and personnel reviews

Enables users to edit only applicable datasets from Bureau-level databases

Utilizes database replication to make authoritative data available to the Agency

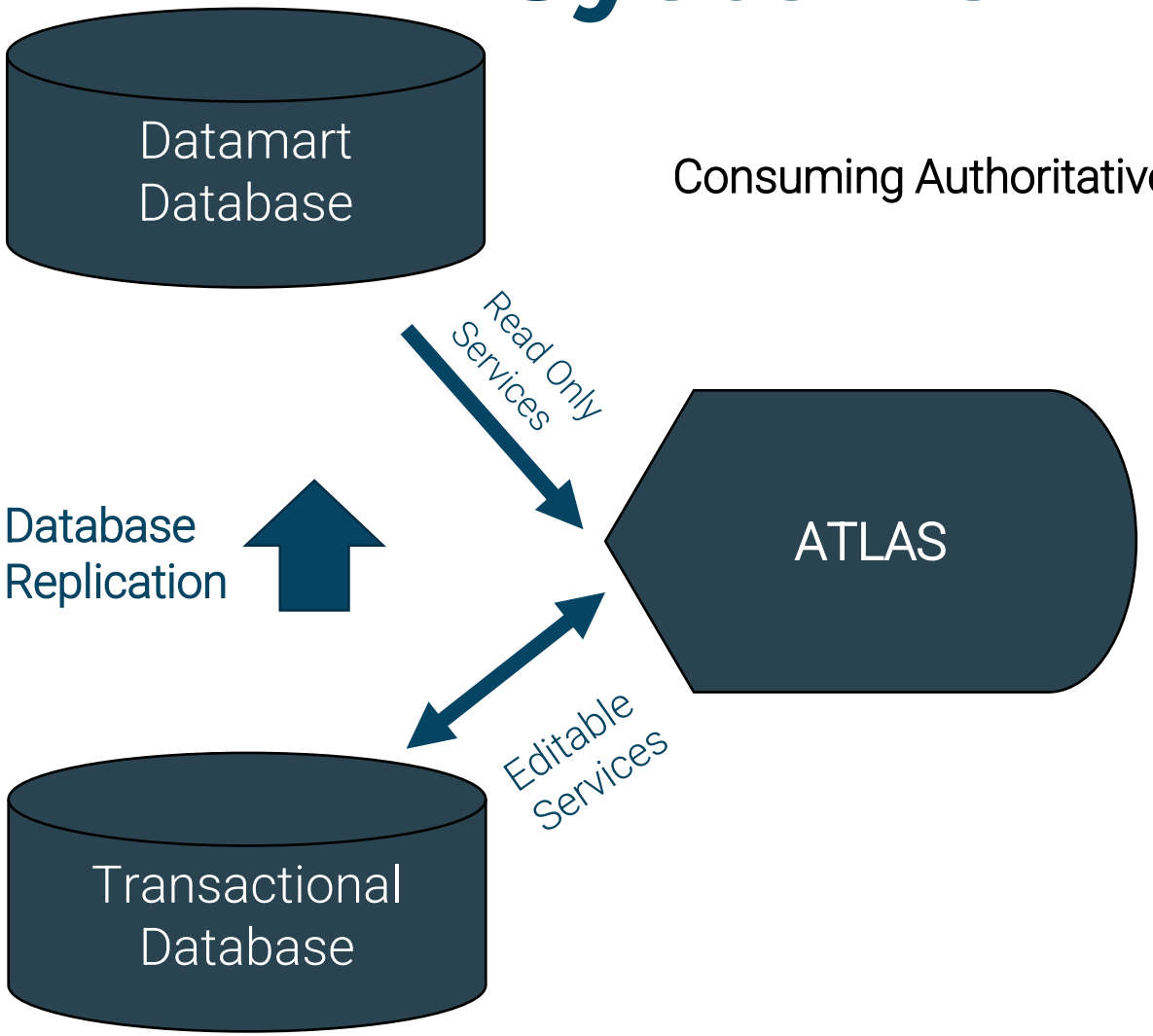
Systems Integration



Consuming Authoritative Data, Running Analysis, Importing Results

CRSMS consumes read only data from the Datamart and runs analysis to create a new data asset – High Frequency Crash Locations – which can then be fed back to the transactional database for availability to Agency personnel

Systems Integration

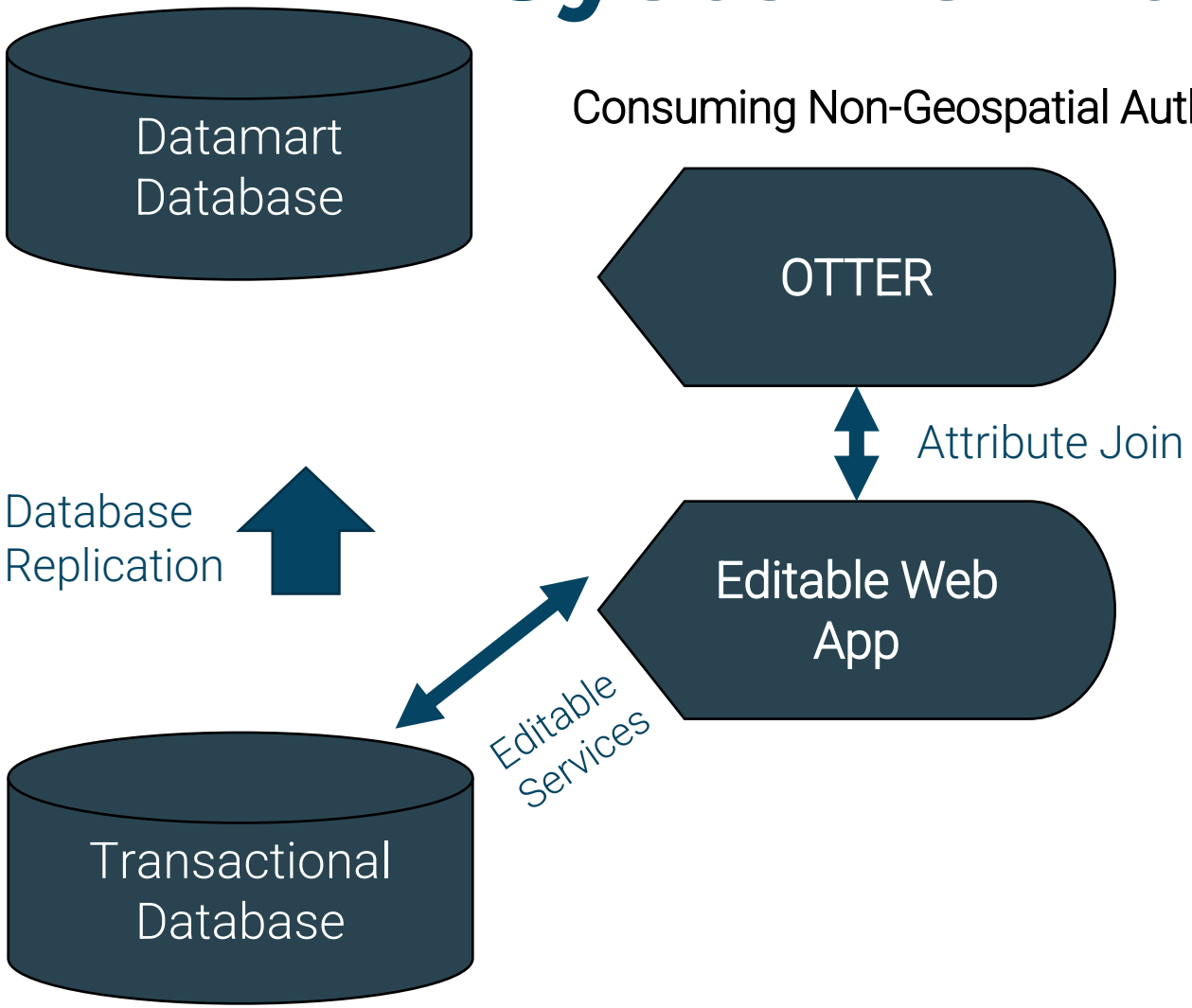


Consuming Authoritative Data, Creating Geospatial Data, Integrating Systems

ATLAS consumes authoritative data, creates new geospatial data through editable web services and created data is reflected in transactional database through Rec/Post/Compress

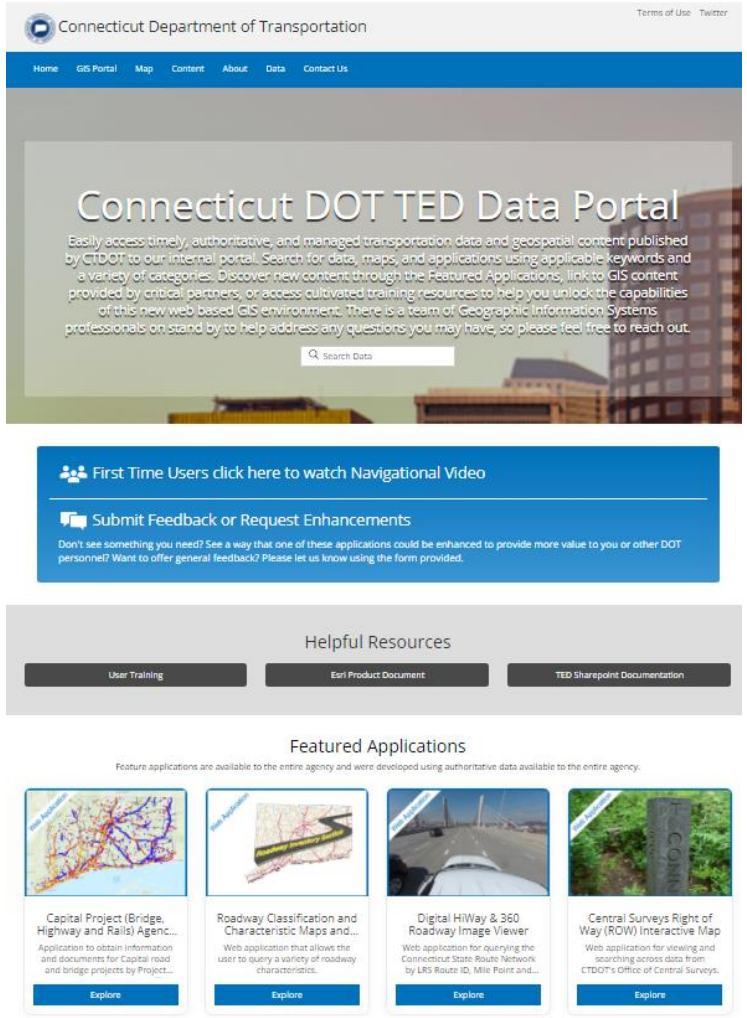
Systems Integration

Consuming Non-Geospatial Authoritative Data, Creating Geospatial Data, Joining Data



OTTER creates authoritative business data, geospatial data is entered in transactional database for replication after joining of business data from OTTER.

TED Data Portal



Utilizes Esri Enterprise Sites Product

Creates cultivated & easy to use view of Agency data and applications

Allows Agency to make available additional content such as tutorials, documentation, other outside linkages (e.g. SharePoint, Forms, etc.)

Creates enterprise level applications based on topic, asset, effort, project, etc.

Utilizes tabbed storymaps for additional efficiency

TED Data Portal Contents

Data

- Extract/Export Data Based on Geospatial or Attribute Filters/Queries
- Web Services for Desktop Analysis

Applications

- Customized Applications for All User Levels
  - Integrate value added items such as roadway imagery

Analysis Reports & Analysis Tools

- Operations Dashboards for Quick Insight
- PowerBI for Querying Tabular Data

Thank You!